CESifo WORKING PAPERS

6656
2017

September 2017

What Does Trade Openness Measure?

Eiji Fujii

CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editors: Clemens Fuest, Oliver Falck, Jasmin Gröschl
www.cesifo-group.org/wp

An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: www.CESifo-group.org/wp

CESifo *Working Paper No. 6656*
Category 8: Trade Policy

What Does Trade Openness Measure?

Abstract

An empirical measure of trade openness is defined as the ratio of total trade to GDP, and represents a convenient variable routinely used for cross-country studies on a variety of issues. However, the effects that the crude measure captures remain ambiguous, making it difficult to interpret the empirical results. Drawing on several strands of the literature, this study examines the informational content of the trade openness measure using intranational and international data. We find that, even for fully integrated economies within a country, trade openness is approximately half as variable as it is for segmented diverse countries around the world. The information it conveys is better characterized as the extent of the economic remoteness and idiosyncratic distribution of sectoral production. The cross-country variation of trade openness derives more from the variability in GDP than trade.

JEL-Codes: F400, F140.

Keywords: trade openness, specialization, gravity model, market integration, price deviations, remoteness.

Eiji Fujii
School of Economics
Kwansei Gakuin University
1-155 Uegahara Ichiban-cho
Japan – Nishinomiya, Hyogo 662-8501
efujii@kwansei.ac.jp

This version: September 7, 2017
The author thanks Kenji Fujiwara and Mark Spiegel for helpful discussions and comments. All remaining errors are solely the author's.

1. Introduction

An empirical measure of trade openness, defined as the ratio of exports plus imports to GDP, is a convenient variable routinely used in a variety of international macroeconomic studies. Use of the variable is pervasive in cross-country studies on a broad range of topics, including growth analyses (Levine and Renelt, 1992), real exchange rate dynamics (Goldfajn and Valdéz, 1999), government size (Rodrik, 1998), output volatility (Fatás and Mihov, 2001), sovereign debt defaults (Levi Yeyati and Panizza, 2011), and the political economy of elections and reforms (Cermeño, Grier, and Grier, 2010).[1] Albeit an admittedly crude measure of openness, the fact that this variable is widely used in the literature highlights the importance of understanding the informational content that it conveys.

The prevalent use in the literature of trade openness seems partly a result of data availability. Because data on total trade as a percentage of GDP are available for many countries from standard international databases, researchers may find them useful in conducting cross-country analyses. However, despite this pervasiveness, the effects that the trade openness variable actually captures remain ambiguous. Although it may well be an intended proxy measure, the question is for what exactly is the variable a good proxy. For instance, what effects are we effectively controlling for by including the trade-to-GDP ratios on the right-hand side of regression equations for cross-country differences in growth, real exchange rate dynamics, and so on?

One exemplary macroeconomic interpretation of the trade openness variable is that it measures the degree to which a domestic economy is exposed to external shocks. To the extent that an economy relies on export demand and imported inputs/products, it is

[1] Some studies refer to the trade-to-GDP ratio as a trade share (Frankel and Romer, 1999) or a trade intensity ratio (Leamer, 1988) instead of trade openness.

subject to potential transmission of disturbances from abroad. However, the trade-to-GDP ratio varies across countries because of differences in trade policies, factor endowments, and geographical locations irrespective of realizations of external shocks. Thus, using variations in trade-to-GDP ratios seems ill-suited for measuring the extent to which external shocks affect domestic economies.[2]

Conceptually, trade openness may be defined as the degree to which an economy maintains its outward orientation in trade. However, empirically, adopting this definition is challenging because it requires detailed and consistent data for many countries on the extent of explicit and implicit trade impediments in various forms that are product-, destination-, and origin-specific and time-variant. Even if such data are available, an additional hurdle exists. Aggregating the detailed data into an overall index that qualifies as a universal measure of trade openness is difficult (Harrison, 1996). In fact, although various indicators are invented, Pritchett (1996) showed that they are virtually uncorrelated with each other, casting doubt on their consistency and reliability.[3]

Although the aforementioned issues may tempt researchers to seek a more practical alternative, using trade-to-GDP ratios as a measure of trade openness introduces significant ambiguity to the interpretation of its effects. The size of trade in relative terms to GDP depends on a variety of factors. In addition to the extent of the outward orientation of trade policy, they include the sizes of the domestic and external markets, the distances to consumers and from producers outside one's own territory, factor endowments that induce specialization in production, and households' preferences for a

[2] To that end, measures based on changes in terms of trade and/or trade-weighted real effective exchange rates seem more suitable. However, their data availability is limited, especially for less developed countries.

[3] For a discussion on the issue, see also Harrison and Rodríguez-Clare (2010), Edwards (1993, 1998), and Rodriguez and Rodrik (2000).

variety in consumption. As a composite of the numerous factors, the empirical measure of trade openness, as convenient as it may be, inflicts difficulty on the interpretation of its effects as documented in various contexts.[4]

This discussion motivates us to examine the informational content of the trade openness variable by drawing on several strands of the literature. In doing so, we analyze both intranational and international data. In particular, we use Japan's prefecture-level data as, so to speak, a miniature world in which assured free trade purges the ambiguity arising from failing to measure various trade restrictions in international contexts.

Furthermore, intra-Japan data on trade, sectoral output, product prices, and so on allow us to evaluate several candidates for the effects captured by the trade openness variable, which is difficult if not infeasible to do in international contexts. Namely, they are economic remoteness (Anderson and van Wincoop, 2003; Baldwin and Harrigan, 2011), market integration (Engel and Rogers, 1996; Parsely and Wei, 2001; Goldberg and Verboven, 2005), uniqueness in sectoral production distributions (Krugman, 1991; Kalemli-Ozcan, Sørensen, and Yosha, 2003), and inclination to pursue economies of scale effects (Alesina, Spolaore, and Wacziarg, 2000; Alesina and Wacziarg, 1998). Through the exercises, this study contributes to the literature by shedding light on the informational content of the widely used albeit difficult-to-interpret empirical variable.

To anticipate, our chief findings are as follows. Even for the fully integrated (and hence perfectly open) regional economies in Japan, the measured trade openness is approximately half as variable as the trade openness of 171 segmented diverse countries around the world. The intranational variation of trade openness embodies two primary

[4] See Leamer (1988) for related problems regarding trade-to-GDP ratios as a measure of trade openness.

informational contents: the extent of economic remoteness and that of idiosyncrasy in sectoral production distributions. We find little evidence of an association between the extent of trade openness and market integration in terms of price conversion in tradables. The variance decomposition exercise we conduct reveals that GDP size variability matters more than does trade to the variability of the trade openness of the international data. Altogether, these results imply that a substantial part of the information conveyed by the cross-country variation in the popular trade openness measure has little to do with openness in the sense of policy outward orientation or the extent of market integration.

The remainder of this paper is organized as follows. Section 2 discusses the trade openness measure from the perspective of the gravity model. By drawing on a few strands of the literature, section 3 considers four possible effects that the trade openness variable may reflect and how they can be alternatively measured. Section 4 describes the data and presents a preliminary analysis. In section 5, we examine the association between trade openness and the alternative measures suggested in section 3. After conducting a variance decomposition analysis in section 6, we conclude in section 7.

2. Trade openness from the gravity perspective

As an empirical measure of trade openness, a plethora of studies adopt

$$OPEN_i = \frac{x_i + m_i}{y_i} = \frac{\sum_{j \neq i} \sum_k (x_{i,j,k} + m_{i,j,k})}{y_i}, \qquad (1)$$

where x_i, m_i, and y_i are country *i*'s exports, imports, and GDP, respectively. With *j* and *k* denoting partner countries and sectors, respectively, $x_{i,j,k}$ ($m_{i,j,k}$) is *i*'s exports to

(imports from) *j* in sector *k*. Time subscripts are suppressed for brevity.

As (1) makes explicit, the variable is constructed through aggregation in multiple dimensions: a domestic country's exports and imports are combined while also being aggregated over all other countries (i.e., the rest of the world) and all sectors. This measurement method is clearly discordant with the microeconomic approach of the empirical trade literature (Harrigan, 1996) that assesses the extent of openness by carefully distinguishing exports and imports, destination/origin countries, and sectors.[5]

For macroeconomic analyses, the sectoral aggregation over *k* in (1) may be justified on the condition that the resulting measurement is taken at best as an approximation in aggregate terms. A crucial question is what proxy information can be effectively conveyed through a variation of (1) across *i*'s.

As a starting point to address the question, we consider aggregate bilateral trade. In particular, a useful framework can be drawn from the gravity equation of trade (Anderson and van Wincoop, 2003; Head and Mayer, 2014). Specifically, we refer to the gravity equation of bilateral trade derived by Anderson and van Wincoop (2003)

$$x_{i,j} = \frac{y_i y_j}{y_W}\left(\frac{t_{i,j}}{p_i p_j}\right)^{1-\sigma} , \qquad (2)$$

where $x_{i,j}$ is total exports from country *i* to *j*, $t_{i,j}$ denotes the bilateral trade cost factors, y_i (y_j) and p_i (p_j) are the income and price indices, y_W is the world income, and σ is the CES parameter.[6] Rearranging terms in (2) yields

[5] Harrigan (1996) assessed the extent of openness to trade in manufacturers in OECD countries by estimating import equations by subsector while allowing for both importer and exporter fixed effects.

[6] Anderson and van Wincoop (2003) noted that p_i and p_j are "multilateral resistance" variables that depend on $t_{i,j}$ and should not be narrowly interpreted as

$$\frac{x_{i,j}}{y_i} = \frac{y_j}{y_W}\left(\frac{t_{i,j}}{p_i p_j}\right)^{1-\sigma} \quad . \tag{2)'}$$

Similarly, we obtain

$$\frac{x_{j,i}}{y_j} = \frac{y_i}{y_W}\left(\frac{t_{j,i}}{p_j p_i}\right)^{1-\sigma} \quad . \tag{3}$$

From (2)' and (3),

$$\frac{x_{i,j} + x_{j,i}}{y_i} = \frac{y_j}{y_W}\left(\frac{t_{i,j}}{p_i p_j}\right)^{1-\sigma} + \frac{y_j}{y_W}\left(\frac{t_{j,i}}{p_j p_i}\right)^{1-\sigma} . \tag{4}$$

In the case that bilateral trade barriers are symmetric such that $t_{i,j} = t_{j,i}$,[7]

$$\frac{x_{i,j} + x_{j,i}}{y_i} = \frac{x_{i,j} + m_{i,j}}{y_i} = 2\frac{y_j}{y_W}\left(\frac{t_{i,j}}{p_i p_j}\right)^{1-\sigma} . \tag{5}$$

When aggregated over all *j*'s, (5) yields an expression equivalent to (1) that

$$\sum_{j\neq i}\frac{x_{i,j} + m_{i,j}}{y_i} = \frac{x_i + m_i}{y_i} = 2\sum_{j\neq i}\frac{y_j}{y_W}\left(\frac{t_{i,j}}{p_i p_j}\right)^{1-\sigma} . \tag{6}$$

According to (6), *i*'s trade openness (1) is determined by the sizes of its trading partners' economies relative to the world, trade-resistant factors (i.e., the term in the brackets), and the elasticity of substitution parameter. This gravity exposition of trade openness constitutes a base for the analyses we subsequently conduct.

We note that defining *j* as the rest of the world generates significant hurdles for empirical implementations in international contexts. As discussed in the introduction, the trade-resistant factors encompassing explicit restrictions and implicit impediments in various forms are difficult to measure consistently. Further, the symmetry assumption

---

consumer price indices.

[7] The symmetry assumption, while generally invalid for international trade, is valid for intranational trade.

$t_{i,j} = t_{j,i}$ generally does not hold. We get around these problems by conducting intranational analyses using Japan as, so to speak, a miniature world in which the prefectural economies engage in mutually free trade.

3. Alternative interpretations and measurements

For a given economy, (1) is simply the ratio between total trade and GDP. To allow for economic interpretation, it is necessary to consider what makes the ratio of trade to GDP high or low, and what it means for an economy to have a high or low ratio. We discuss several candidates by drawing on different strands of the literature. For each, we also introduce an alternative measurement that well fits the interpretation.

3.1 Economic remoteness

Assuming that the CES parameter σ is constant across *i*'s, the gravity exposition of trade openness (6) consists of two key elements: the relative size of trading partners and the trade-resistant factors. In other words, the extent of trade openness is determined by how large the partners are and the severity of the trade impediments lying between domestic and partner economies. As discussed in section 1, it is not straightforward to consistently gauge international trade restrictions in a variety of forms. However, intranationally, no artificial trade barriers exist and the sole impediment is trade cost, which tends to increase with interregional distance.

The information on partner size and distance thereto can be succinctly summarized by the remoteness index proposed by Baldwin and Harrigan (2011)

$$REM_i = \left[\sum_j y_j d_{i,j}^{-\eta}\right]^{-1} , \qquad (7)$$

where $d_{i,j}$ is the distance between economies *i* and *j*. Following Baldwin and Harrigan (2011), we set η equal to unity.[8] A larger value of (7) indicates a greater extent of economic remoteness in the sense that the trading partners are smaller and/or located farther away.[9] Thus, the gravity perspective suggests a hypothesis that the primary information embodied in (1) be the extent of economic remoteness. If so, (1) should be significantly negatively associated with the direct measure of remoteness (7).

3.2 Market integrating forces in tradables

Although the gravity model provides significant insight, other strands of the literature offer different perspectives on what can be conveyed by variations in (1). In influential studies on national price levels, Kravis and Lipsey (1987, 1988) use the trade openness to gauge the degree to which international trade forces drive traded goods prices toward uniformity across countries. Use of trade openness continues to be popular in the subsequent literature on national price levels and real exchange rates.[10]

From the aforementioned perspective, trade openness indicates the strength of the forces that integrate the domestic market in tradables with external markets. In other words, (1) can be regarded as a quantity-based proxy measure of market integration of tradables. In general, the extent of market integration is better measured by price-based information, such as intermarket price differentials and their variances (Engel and Rogers, 1996; Parsely and Wei, 2001; Goldberg and Verboven, 2005). If the trade openness variable reasonably captures the extent to which the forces of arbitrage apply

[8] See Head and Mayer (2014) for issues regarding various remoteness measures proposed in the literature.
[9] An implicit assumption is that trading costs increase with distance.
[10] See, for instance, Cheung and Lai (2000), Broda (2006), and Fujii (2015), among others.

converging pressure on the prices of tradables, then it should be negatively associated with the size of intermarket price differentials.

We gauge the price deviation in the tradable sector *k* of economy *i* from others by

$$DEV_{i,k} = (P_{i,k} - \frac{1}{N-1}\sum_{j \neq i} P_{j,k})^2 , \quad (8)$$

where $P_{i,k}$ is the price of *k* in *i* and *N* is the number of all economies. The previous discussion leads us to a hypothesis that more trade-open economies tend to have smaller tradables price deviations and, hence, (1) and (8) are significantly negatively associated with each other.

3.3 Idiosyncratic factor endowment and sectoral specialization

Unlike the gravity model, the Heckscher-Ohlin model highlights the roles of heterogeneous factor endowments in motivating specialization and trade. From this conventional perspective, the trade openness variable can be viewed as an implicit indicator of the degree of specialization in production induced by heterogeneous factor endowments. The point is well articulated theoretically by Leamer (1988) that, in the absence of trade barriers, (1) is essentially a measure of the peculiarity of the resource supply.

While directly measuring factor endowment is difficult, the extent of specialization can be quantified by using sectoral GDP data. More specifically, we adopt the index of specialization proposed by Kalemli-Ozcan, Sørensen, and Yosha (2003)

$$SP_i = \sum_k \left(\frac{y_{i,k}}{y_i} - \frac{1}{N-1}\sum_{j \neq i} \frac{y_{j,k}}{y_j} \right)^2 , \quad (9)$$

where $y_{i,k}$ and y_i , respectively, are the sector *k* and total outputs of *i*.[11]

[11] The idea of the specialization index originates from Krugman (1991). The index he

In theory, specialization and trade go hand in hand. However, the relationship can be somewhat complicated in the empirical measure. Precisely, (9) quantifies the extent of idiosyncrasy in *i*'s sectoral output distribution vis-à-vis others. Thus, if economies specialize in different sectors to engage in interindustry trade with each other, then the extent of specialization (9) should be positively associated with the trade openness of (1). However, if economies specialize in the same sectors to engage in intraindustry trade, then a high trade-to-GDP ratio can occur with a low specialization index value. In this case, (1) and (9) will not be positively associated with each other. The point is that if intraindustry trade dominates interindustry trade, then the trade-to-GDP ratio may not be positively associated with the sectoral specialization index. In fact, they may exhibit a negative correlation.

A disjunction between specialization and trade can potentially (though probably less likely) occur also when economies differ substantially in their preferences. If domestic production in each economy takes place primarily to meet the local demand shaped by region-specific heterogeneous preferences, then a distinctive sectoral production structure captured by (9) does not necessarily lead to a greater trade-to-GDP ratio (1).

3.4 Inclination to pursue economies of scale

Another interpretation of the trade openness variable derives from the literature on the relationship between economic integration and the equilibrium size and number of countries (Alesina and Spolaore, 1997; Alesina, Spolaore, and Wacziarg, 2000). To the

---

proposed adopts sectoral shares in employment rather than output and absolute values instead of squares. We rely on output data because the corresponding data on sectoral employment are not available. Kalemli-Ozcan et al. (2003) used (9) to assess the extent of specialization within manufacturers by limiting *k* as manufacturing subsectors and defining y_i as total manufacturing output. In our intra-Japan context, products and services other than manufacturers can also be tradeable. Thus, we consider all sectors for *k*.

extent that returns are increasing with the scale of production, smaller countries suffer more severely from trade restrictions because their productivities stay low given limited domestic market size. In contrast, large countries can enjoy economies of scale in their domestic markets. Therefore, smaller economies have stronger incentives than larger ones to become more open to trade.[12] Therefore, an economy's size matters to trade openness even after trade is scaled by GDP as (1).

This argument suggests that the ratio of trade to GDP can be driven by the inclination of a country to expand its market size beyond its own territory to pursue economies of scale effects. This perspective constitutes a credible explanation for why small economies such as those of Luxembourg and Singapore are very open, whereas large ones such as those of the United States and Japan are far less so based on trade-to-GDP ratios. When faced with severe limitations on domestic market size, economies have strong incentives to pursue specialization and expand trade. Consequently, they adopt a liberal trade policy.

In the literature, a standard market size measure is population.[13] Following this convention, we use logged total population as a measure of the inclination to exploit the economies of scale effects. If the trade openness variable effectively reflects the strength of the incentives to exploit the scale effects, it should be negatively associated with domestic market size as approximated by population size.

[12] Alesina and Wacziarg (1998) argued that the positive association between openness and government size highlighted by Rodrik (1998) is driven by the country size effect and should not be viewed a direct causal relationship. Ram (2009) provided counter evidence to the argument.

[13] We also consider GDP as a measure of market size. Not surprisingly, GDP and total population exhibit strong positive correlations, and their replacement exerts little impact on the empirical results.

4. Data and preliminaries

4.1 Data description

In international contexts, (1) measures *i*'s trade (in relative GDP terms) vis-à-vis the rest of the world. Thus, analyzing its contents requires data on the other variables also in relation to the rest of the world, which may not be obtainable. For instance, it is infeasible to secure data on price deviations in tradables and/or sectoral specialization for all countries around the world. The intranational approach we pursue makes it feasible to examine the effects, which is otherwise difficult to do.

The other merit of using intranational data is that it enables us to examine the behavior of the trade openness variable in a controlled environment in which trade policies/restrictions play no role and all economies are assured to be uniformly and fully open to trade with each other. Under these circumstances, it is useful to examine the variation that the measured trade openness still exhibits and what it reflects. This information should be taken into account when interpreting the effects of trade openness in international contexts in which additional sources of variations, such as differences in trade policy, come into play.

The intranational data we analyze are Japanese prefecture-level data. Japan consists of forty-seven prefectures, listed in Table A-1 in the appendix, which are geographically defined administrative units largely corresponding to the states in the United States. Although no artificial trade barriers exist between the prefectures, natural impediments do. In general, transport cost increases with distance and, hence, remoteness can become a major trade-resistant factor.

The *Annual Report on Prefectural Accounts* published by the Cabinet Office of Japan provides prefectural income accounting data. From the 2012 CD-ROM of the

report, we extract data on prefectural GDP in total and by sector, import from and export to all other prefectures, and population.[14] The sample period is from 1996 to 2009. The sectors for which disaggregated output data are available are listed in the data appendix. Unfortunately, the sectoral GDP series for the Okinawa prefecture are incomplete. Consequently, the specialization index (9) is constructed for forty-six prefectures except for Okinawa.

To quantify the extent of economic remoteness by (7), we gauge the interprefecture distances (in kilometers) by those between the prefectural capitals using a calculator available at the website of the Geospatial Information Authority of Japan, Ministry of Land, Infrastructure, Transport and Tourism.

To measure price deviations in tradables by (8), we use the Regional Difference Index of Prices (RDIP) published by the Statistical Bureau of the Ministry of Internal Affairs and Communications. Using information collected by the national price survey, the RDIP reveals regional price level differences as indices to the national average. The survey takes places in five-year intervals to consistently record prices of precisely defined products and services throughout the country. Although the RDIP series is available for various product categories, our purpose is to measure price deviations in tradables.[15] Thus, we adopt the RDIP of the following highly tradable categories: clothing and footwear; and furniture and household utensils.

[14] Because of a lack of data, measuring the extent of openness to international trade by prefecture is not possible. However, we note that Japan is among the least open countries to international trade, with an average trade-to-GDP ratio of only 24% for 1996–2009. The openness for interprefectural trade is far greater, at approximately 133%. These facts suggest that trade vis-à-vis other prefectures generally has far more significant implications for prefectural economies.

[15] RDIP data are available for the following categories: general; general except for fresh foods; general except for rents; foods; housing; utilities (i.e., water and electricity); furniture and household utensils; clothing and footwear; medical services;

During the 1996–2009 period covered by the prefectural income accounting data, the RDIP are available only for 1997, 2002, and 2007. Hence, we use the observations of these three years for the analyses requiring (8).

We also use standard international databases, specifically the World Bank's World Development Indicator (WDI) and the IMF's Direction of Trade Statistics (DOT). The WDI data on total trade as a percentage of GDP are based on trade vis-à-vis the rest of the world. We use DOT data to calculate trade within the OECD, the EU, and the Eurozone.

4.2 Trade openness by intranational and international data

Panel A of Table 1 presents the descriptive statistics for the 1996–2009 average trade openness of the forty-seven Japanese prefectures. On average, intra-Japan trade openness is approximately 130%. Of the forty-seven prefectures, the least open is the remote island of Okinawa (63%) and the most open is geographically centrally located Mie (215%).

How do the figures compare with international counterparts? We report the corresponding international statistics in panel B of Table 1. After extracting the data for all countries from the WDI database, we retain 171 countries that have no missing observations for 1996–2009. Not surprisingly, the average trade openness of the 171 countries around the world is substantially lower at 88%. Further, the difference between the most and least open countries (Singapore 373% and Brazil 24%) is larger than that of intra-Japan data.

For additional insights, we also consider the OECD, EU, and Eurozone country samples. For comparison purposes, Table 2 summarizes the features of the different

---

transportation and communication; education; entertainment; and miscellaneous.

samples. The OECD sample precludes a large number of less developed countries included in the full sample. These countries tend not to be on the same level as the developed countries in terms of trade restrictions. They also tend to have much smaller GDP. The EU sample consists of countries clustered in Europe that have shared access to the common market. The Eurozone sample contains only those that additionally share a common currency. These international subsamples are considered middle cases between the full world sample and the intra-Japan sample in which prefectural economies are fully integrated through a common market, currency, and fiscal system. In addition, Japanese prefectures are geographically more condensed than the EU and Eurozone countries.

The trade openness of the OECD, EU, and Eurozone country subsamples are also reported in panel B of Table 1. Interestingly, limiting the sample to OECD countries further lowers the average openness, albeit modestly, to 83%. Given that the OECD sample retains large economies, such as the United States and Japan, while excluding numerous small less developed economies, the lower average openness may in part reflect the size effects. Nonetheless, the overall sample statistics appear surprisingly similar between the world and OECD samples. In other words, whether or not to include a large number of less developed economies in the sample does not seem to matter much, which reinforces our motivation to question the effects truly captured by the trade-to-GDP ratios in the name of trade openness.

The openness of EU member countries is on average higher, at approximately 100%, presumably reflecting the effects of European market integration and geographical proximity. Further restricting the sample to the Eurozone countries elevates the average openness to 107%. In accordance with the anticipation, the extent of the EU and

Eurozone samples' trade openness exceeds that of the world sample while falling short of that of the Japanese sample.[16]

A cross-sample comparison of the maxima reveals that the prefecture most open to intra-Japan trade (Mie, 215%) is substantially less open than countries such as Singapore (373%) and Luxembourg (274%) are to international trade. As a whole, Japan is the least open OECD country, with an average trade openness of only 24%, and is the second least open of the 171 countries, next to only Brazil.[17]

To be an informative measure, trade openness should have sufficient cross-sectional variations. As displayed in the fourth column of Table 1, the standard deviation of intra-Japan trade openness is approximately 33%, whereas the international counterparts fall between 46% and 55%. The fifth column contains the coefficient of variation (i.e., the ratio of the standard deviation to the mean). Using this measure, the intranational and international comparison is 25% versus 47%–57%. Relative to the sizes of the standard deviations and the coefficients of variation, respectively, trade openness within Japan is 66% and 45% as variable as it is across 171 countries around the world. That is, the trade openness of fully integrated, equally open, and geographically condensed economies is approximately half as variable as it is for diverse countries scattered around the world and is segmented by artificial and natural trade impediments. Again, these observations reinforce our motivation to ask about the effects that we actually capture using trade-to-GDP ratios.

[16] Note that the trade openness series extracted from the WDI database is based on the total trade vis-à-vis the rest of the world. Thus, the statistics for the EU and Eurozone groups do not indicate trade openness within each group. Nonetheless, to the extent that common markets and common currency enhance trade between member countries, the EU and Eurozone groups are expected to have a higher degree of trade openness than the world or the OECD samples.

[17] The United States is the third least open country, with average openness of 24.5%.

5. Evaluating the candidates

5.1 Pairwise co-movement

In section 3, we provide four possible economic interpretations of the effects reflected by the trade openness variable. Namely, they are the extent of economic remoteness, market integration in tradables, idiosyncratic sectoral specialization, and inclination to exploit economies of scale. We also introduced alternative measures of these effects. In this subsection, we use Japanese data to test whether the measures of the four effects exhibit significant co-movements with the trade openness variable.

Table 3 presents a correlation matrix based on averages of the 1997, 2002, and 2007 observations.[18] Among the four alternatives, the indices of economic remoteness and idiosyncratic sectoral specialization exhibit significant correlations of −0.67 and 0.73, respectively, with trade openness. The opposing signs are as anticipated. A more trade-open prefecture tends to be less remote (i.e., closer to larger markets) and more uniquely specialized, implying that interindustry trade—rather than intraindustry trade—prevails among the prefectures.

The negative correlation of −0.36 between the remoteness and specialization indices, is also statistically significant. Further, the remoteness index shares a significant positive correlation with the deviations of clothing and footwear prices. Thus, economically remote prefectures also tend to have large price deviations. Nonetheless, trade openness does not exhibit a significant correlation with the price deviations of either of the two tradable product categories. The correlation between trade openness and population size is insignificant and signed, in contrast to our expectations.

[18] Regional price data are available only for these years, as noted in sub-section 4.1. We also generate year-by-year results that convey a similar message. To conserve space, they are not reported but are available on request.

For robustness, we also examine the rank correlations by ordering the prefectures according to trade openness and the other four factors. The merit of the nonparametric rank correlation test is that it does not require a linear relationship between the variables. The exercise helps us identify the factors that well mimic trade openness when ranking the prefectures.

Table 4 presents the Spearman rank correlations on the basis of the three-year average data. In accordance with the correlation coefficient results, the trade openness variable exhibits statistically significant rank correlations with the measures of economic remoteness and sectoral specialization. A prefecture ranked high by trade openness also tends to be ranked high by the extent of idiosyncratic specialization in production while ranked low in terms of remoteness. The results are consistent with the view based on the gravity equation. They also suggest that a tandem relationship of trade and specialization holds well intranationally, implying dominance of interindustry trade within Japan.

From the rank correlations among the four factors, we additionally observe that economic remoteness and market size are negatively associated with each other. Not surprisingly, economically remote prefectures tend to be small in terms of population.

Altogether, the results in this subsection indicate potential issues regarding using (1) as a measure of openness. While associated with the indices of economic remoteness and sectoral specialization, the trade openness variable does not exhibit a significant direct association with the extent of tradables' price deviations or market size, unlike the index of economic remoteness.

5.2 Explanatory power for the cross-sectional variation

In this subsection, we conduct a regression analysis to account for the cross-sectional variation of trade openness. We emphasize that the purpose of the exercise is limited to evaluating the four candidates in terms of their explanatory power for cross-sectional variation in the measured trade openness. The regressions presented are not intended for any causal inference and should be viewed accordingly. We limit the focus of our discussion to the model significance and explanatory power.

Pooling the data for 1997, 2002, and 2007, we estimate

$$\ln OPEN_{i,t} = \sum_t \phi_t D_t + X_{i,t}'\Phi + \varepsilon_{i,t}, \qquad (10)$$

where D_t denotes the year-specific dummy variables and X_i is a vector consisting of the four alternatives in logarithms, namely, the measures of economic remoteness, market integration, sectoral specialization, and scale effects. To make the estimates comparable across all specifications, we exclude Okinawa from the sample given missing observations on the specialization index.

Table 5 presents the estimates. As a benchmark, we initially regress the trade openness variable only on the year-specific constants, which yields an adjusted R^2 estimate of .021 and an insignificant F-statistic as displayed in column 1. Retaining the year-specific intercepts, we then estimate bi-variate specifications to compare the marginal explanatory power of the four alternatives, each as a sole regressor. The results are displayed in columns 2 through 5.[19] The adjusted R^2 estimates indicate that the remoteness and specialization variables (specifications 2 and 4) possess substantial marginal explanatory power for trade openness. The F-statistics also endorse only these two variables in terms of model significance.

[19] In the results reported in Table 4, price deviations are measured using the prices of clothes and footwear. Replacing them with the furniture price deviations does not significantly affect the results. The results are available on request.

When combined, the remoteness and sectoral specialization indices (along with the year-specific intercepts) account for nearly 70 % of the variation in the measured trade openness as shown in column 6. As observed in columns 7 through 9, there is little marginal gain in the model's explanatory power by additionally using the information on tradables price deviations and/or population size.

Overall, the results thus far suggest that, in the absence of artificial trade barriers, cross-sectional variation in trade openness conveys information primarily on economic remoteness and the distinctiveness of sectoral production distributions. The latter is consistent with the insight of Leamer (1988) that (1) measures the extent of the peculiarity of the resource supply in the absence of trade barriers. In the meantime, we also find that approximately 30% of the total variation in trade openness remains unaccounted for by the four effects we consider. In the next section, we decompose the variability of trade openness to understand its component sources and their relative importance.

6. Variance decomposition analysis

The variability of trade openness depends on the variability of trade, the variability of GDP, and the co-variability between trade and GDP. More specifically, the following decomposition applies to the variance of (1) in logarithm

$$\begin{aligned} Var(\ln OPEN) &= Var(\ln TRADE - \ln GDP) \\ &= Var(\ln TRADE) + Var(\ln GDP) - 2Cov(\ln TRADE, \ln GDP) \end{aligned}. \quad (11)$$

$Var(\ln GDP)$ can be taken as a measure of the heterogeneity of the size of the economy, which depends on the nature of the sample under consideration. For instance, considering advanced and nonadvanced economies together tends to generate a large

$Var(\ln GDP)$ value. In contrast, a sample consisting of smaller-scale regional economies within a country will naturally make $Var(\ln GDP)$ small.

The remaining two terms on the right-hand side of (11) contain trade. For them, it is useful to first consider the determinants of trade size (in absolute terms) of a given economy. Abstracting from detailed conditions, trade size depends primarily on the size of the economy. All else held constant, a large economy trades more in absolute terms than a small economy. Thus, in principle, $Var(\ln TRADE)$ depends on $Var(\ln GDP)$, and $Cov(\ln TRADE, \ln GDP)$ should be positive.[20]

Once we allow other conditions to vary, differences in trade policy, factor endowments, geographical locations, and so on intervene to alter trade size for a given GDP size and, hence, alter $Cov(\ln TRADE, \ln GDP)$. The factors that can make the co-variance smaller than otherwise include restrictive trade policy, severe natural trade impediments, homogeneity in factor endowments, and significant scale economy effects that motivate smaller economies more than larger ones to expand their trade.[21]

A useful way of analyzing the decomposition is to measure the three components in relative terms to the total variance. The relative shares indicate the contributions by component while taking the heterogeneity of GDP size for the sample as given. In other words, they inform us of the relative importance of GDP variability, trade variability, and their co-variability and whether such importance differs noticeably across different samples.

---

[20] In the long term, GDP can also depend on trade if trade causes growth. In this case, $Var(\ln GDP)$ may also depend on $Var(\ln TRADE)$. For an empirical assessment of the trade-growth nexus, see Dollar and Kraay (2003), Edwards (1993, 1998), Frankel and Romer (1999), and Rodriguez and Rodrik (2000).

[21] The effects of GDP size, trade restrictions, and economies of scale are intertwined. As articulated by Alesina, Spolaore, and Wacziarg (2000), a smaller country benefits more from less restrictive trade when economies of scale effects are present.

Table 6 summarizes the variance decomposition results. The relative contributions of GDP variance, trade variance, and GDP-trade co-variance to total variance are denoted in percentage terms in columns (i), (ii), and (iii), respectively. The lack of variation in GDP size in the intra-Japan sample leads to the relatively small contribution of $Var(\ln GDP)$ to the total variation. The share of 922% is less than half the corresponding share of 2,067% for the world sample. Nonetheless, the OECD sample appears much closer to the intra-Japan sample than the world sample in terms of the contribution of $Var(\ln GDP)$, which is 1,045%. The EU and Eurozone samples (1,681% and 1,616%, respectively) lie between the world and the OECD samples.

A comparison of the world and OECD samples indicates that excluding a large number of less developed economies substantially reduces the share of the GDP size variability, as anticipated. Interestingly, the shares of trade variance and co-variance decline even more overtly. The EU and Eurozone samples turn out to have greater variation in GDP and trade than the OECD sample.

Regarding the contribution of $Var(\ln TRADE)$, the intra-Japan sample appears largely comparable to the international subsamples. The share of 1,090% well exceeds the OECD's 751% but falls short of the EU and Eurozone figures of 1,333% and 1,247%, respectively.

When measured in relative terms to GDP variability, trade variability is greater with the intra-Japan sample than with the international counterparts. The ratio displayed in column (iv) of $Var(\ln TRADE)$ to $Var(\ln GDP)$ exceeds unity only for the intra-Japan sample. For all international samples, $Var(\ln TRADE)$ is less than $Var(\ln GDP)$. The same applies to the ratio displayed in column (v) of

$Cov(\ln TRADE, \ln GDP)$ to $Var(\ln GDP)$. Given widely used international data, variation in (1) results more from the variability of GDP than the variability of trade.

In panel C of the table, we report the decomposition results by considering only within-group trade for the Eurozone, EU, and OECD samples, such that they are more strictly comparable with those of the intra-Japan data.[22] This recalculation lowers the relative shares of all components across the samples and highlights the distinctiveness of the OECD sample in terms of the small relative shares of each component. The recalculation also shifts the EU and Eurozone samples away from the world sample and toward the Japanese sample in terms of similarity in the relative component shares.

In summary, we develop the main message of the results as follows. GDP size heterogeneity matters much to the variation of trade openness. In fact, given standard international data, cross-country variations in (1) derive more from GDP than from trade. Consequently, (1) as a measure of trade openness may not exhibit sufficient variability even if trade is relatively variable when the sample consists of economies with similar GDP sizes, which has two implications.

First, the intra-Japan data we adopt can be deemed an exemplary sample with which trade openness variability is restrained because of the lack of GDP size variability. In addition, the prefectural economies are fully integrated and completely open to trade with each other. However, even given these extreme conditions, we still observe trade openness by (1) to be approximately half as variable as it is with the world sample. This variability primarily reflects the differences in economic remoteness and sectoral production distributions rather than openness in terms of outward policy orientation.

[22] To calculate, trade openness within the OECD, EU, and Eurozone countries (rather than vis-à-vis the ROW), we use the trade matrix for each group as extracted from the IMF's DOT and GDP in current U.S. dollar terms.

Second, the evidence on intra-Japan data may understate the importance of the inclination to exploit economies of scale effects. The insignificance of the own market size effects in section 5 may be driven by the insufficiency of the GDP size variability specific to the intra-Japan sample.

7. Conclusions

Faced with severe data constraints, a researcher may choose to sacrifice some conceptual accuracy over data availability when deciding on the empirical variables to adopt. This applies particularly to studies covering a wide cross-section of countries for which desirable data are often difficult to obtain. Although the ratio of total trade to GDP is admittedly a crude measure of trade openness, data availability makes it a popular choice for empirical analyses. Despite the warning by Leamer (1988), we continue to see the variable used routinely in the literature on a wide range of topics. Although the variable may well be justified as a proxy measure, the question is for what exactly the variable can be a good proxy.

This paper contributes to the literature by empirically exploring the informational content of the heavily used albeit often only vaguely interpreted measure of trade openness. For accurate interpretation of the empirical results, understanding the effect that is actually controlled for by taking into account the differences in the trade-to-GDP ratios is indispensable.

Using intranational and international data, we examined the nature of the trade openness variable. In particular, intra-Japan data enable us to study the trade openness variable in an environment in which no artificial trade restrictions interfere. We observed substantial variability in the extent of the measured trade openness across

prefectures within Japan despite the fact that they are uniformly under free trade vis-à-vis each other and, hence, fully "open." Further, we find that the variability is well associated with economic remoteness and idiosyncratic sectoral distribution in production.

The variance decomposition results suggest for the international data that the variability of trade openness derives more from the variability of GDP size than trade. By construction, (1) is as much a measure about GDP as it is about trade. These findings together illustrate what one may end up capturing by adopting the trade-to-GDP ratio in the name of "trade openness."

We acknowledge that the intranational analyses do not inform us directly of the importance of differences in trade policy because their effect is preempted by the sample construction. Nonetheless, the intra-Japan sample can be viewed as an exemplary case near the lower bound in terms of trade openness variability given the lack of policy differences and the low variability of GDP size. From this perspective, our findings imply that a substantial portion of international trade openness is likely to have little to do with openness per se. The conveyed information can be more appropriately characterized as the extent of economic remoteness and idiosyncratic distribution of sectoral production. In a nutshell, the name of the variable is deceptive.

Data Appendix

Sources of the intra-Japan data

Annual Report on Prefectural Accounts 2012 CD-ROM, Department of National Accounts, Economic and Social Research Institute, Cabinet Office, Government of Japan.

Regional Statistics Database, Official Statistics of Japan.

Sources of international data

World Development Indicators, the World Bank.

Direction of Trade Statistics, the International Monetary Fund.

International distances are calculated as distances between national capitals by using the calculator available at http://www.infoplease.com/atlas/calculate-distance.html. The computation is for the great circle distance between points, and do not account for differences in elevation.

Notes

While the *Annual Report* contains both nominal and real data, real series have an advantage of being free from possible cross-prefectural difference in relative price of government purchases. We thus use the real data.

Data on the disposable income (DI) are available only in nominal figures. We convert them into real series using the prefectural GDP deflators. Also, there are a couple of prefecture-specific incidents of missing observations. First, the observations on Tokyo's DI are missing altogether. We obtain the 2001-2009 nominal figures from Tokyo Metropolitan Government's site (http://www.toukei.metro.tokyo.jp). These figures are then converted into real terms using Tokyo's GDP deflator. Also, Aichi prefecture's export and import are available only in nominal figures. They are also converted into real series using Aichi's prefectural GDP deflator.

Sectors for the specialization index

The specialization index (9) in the main text is constructed by using the output data on the following sectors:

A. Industries

A1. Agriculture, forestry and fishing

1) Agriculture, 2) Forestry, 3) Fishing

A2. Mining

A3. Manufacturing

1) Food products and beverages, 2) Textiles, 3) Pulp, paper and paper products, 4) Chemicals, 5) Petroleum and coal products, 6) Non-metallic mineral products, 7) Primary metal, 8) Fabricated metal products, 9) Machinery, 10) Electrical machinery, equipment and supplies, 11) Transport equipment, 12) Precision instruments, 13) Others

A4. Construction

A5. Electricity, gas and water supply

1) Electricity supply, 2) Gas and water supply

A6. Wholesale and retail trade

A7. Finance and insurance

A8. Real estate

A9. Transport and communications

A10. Service activities

B. Producers of government services

B1. Electricity, gas and water supply

B2. Service activities

B3. Public administration

C. Producers of private non-profit services to households

C1. Service activities

Table A-1. List of the prefectures in Japan

1	Hokkaido	25	Shiga
2	Aomori	26	Kyoto
3	Iwate	27	Osaka
4	Miyagi	28	Hyogo
5	Akita	29	Nara
6	Yamagata	30	Wakayama
7	Fukushima	31	Tottori
8	Ibaraki	32	Shimane
9	Tochigi	33	Okayama
10	Gunma	34	Hiroshima
11	Saitama	35	Yamaguchi
12	Chiba	36	Tokushima
13	Tokyo	37	Kagawa
14	Kanagawa	38	Ehime
15	Niigata	39	Kochi
16	Toyama	40	Fukuoka
17	Ishikawa	41	Saga
18	Fukui	42	Nagasaki
19	Yamanashi	43	Kumamoto
20	Nagano	44	Oita
21	Gifu	45	Miyazaki
22	Shizuoka	46	Kagoshima
23	Aichi	47	Okinawa
24	Mie		

Table A-2. List of countries by group

	OECD	EU	Euro-zone
1	Australia	Austria	Austria
2	Austria	Belgium	Belgium
3	Belgium	Bulgaria	Cyprus
4	Canada	Croatia	Estonia
5	Chile	Cyprus	Finland
6	Czech Republic	Czech Republic	France
7	Denmark	Denmark	Germany
8	Estonia	Estonia	Greece
9	Finland	Finland	Ireland
10	France	France	Italy
11	Germany	Germany	Latvia
12	Greece	Greece	Lithuania
13	Hungary	Hungary	Luxembourg
14	Iceland	Ireland	Malta
15	Ireland	Italy	Netherlands
16	Israel[f]	Latvia	Portugal
17	Italy	Lithuania	Slovak Republic
18	Japan	Luxembourg	Slovenia
19	South Korea	Malta	Spain
20	Luxembourg	Netherlands	
21	Mexico	Poland	
22	Netherlands	Portugal	
23	New Zealand	Romania	
24	Norway	Slovak Republic	
25	Poland	Slovenia	
26	Portugal	Spain	
27	Slovak Republic	Sweden	
28	Slovenia	United Kingdom	
29	Spain		
30	Sweden		
31	Switzerland		
32	Turkey		
33	United Kingdom		
34	United States		

Notes: The table lists the sample countries used in the empirical analyses in the main text.

Table A-3. List of countries in the world sample

Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Aruba, Australia, Austria, Azerbaijan, The Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei, Darussalam, Bulgaria, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Comoros, Dem. Rep. Congo, Rep. Congo, Costa Rica, Cote d'Ivoire, Croatia, Cuba, Cyprus, Czech Republic, Denmark, Dominica, Dominican Republic, Ecuador, Arab Rep. Egypt, El Salvador, Equatorial Guinea, Eritrea, Estonia, Ethiopia, Fiji, Finland, France, Gabon, The Gambia, Georgia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guinea-Bissau, Haiti Honduras, Hong Kong SAR, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Kazakhstan, Kenya, Kiribati, Rep. Korea, Kuwait, Kyrgyz Republic, Lao PDR, Latvia, Lebanon, Lesotho, Libya, Luxembourg, Macao SAR, Macedonia, FYR Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Palau, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Puerto Rico, Qatar, Romania, Russian Federation, Rwanda, Samoa, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Singapore, Slovak Republic, Slovenia, Solomon Islands, South Africa, Spain, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan, Swaziland, Sweden, Switzerland, Tajikistan, Tanzania, Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, United Kingdom, United States, Uruguay, Uzbekistan, Vanuatu, Venezuela, Vietnam, , West Bank and Gaza, Rep.Yemen, Zambia Zimbabwe.

Reference:

Alesina, Alberto and Enrico Spolaore. 1997. On the number and size of nations. *Quarterly Journal of Economics,* 112, 1027-1054.

Alesina, Alberto, Enrico Spolaore, and Romain Wacziarg. 2000. Economic Integration and Political Disintegration. *American Economic Review,* 90 (5), 1276-1296.

Alesina, Alberto and Romain Wacziarg. 1998. Openness, country size and government. *Journal of Public Economics,* 69, 305-321.

Anderson, James E. and Eric van Wincoop. 2003. Gravity with gravitas: A solution to the border puzzle. *American Economic Review,* v.93 n.1, 170-192.

Baldwin, Richard and James Harrigan. 2011. Zeros, quality, and space: Trade theory and trade evidence. *American Economic Journal: Microeconomics,* 3, 60-88.

Broda, Christian. 2006. Exchange rate regimes and national price levels. *Journal of International Economics,* 70 (1), 52-81.

Cermeño, Rodolfo, Robin Grier, and Kevin Grier. 2010. Elections, exchange rates and reform in Latin America. *Journal of Development Economics*, 92, 166-174.

Cheung, Yin-Wong, and Kon S. Lai. 2000. On cross-country differences in the persistence of real exchange rates. *Journal of International Economics*, 50, 375-397.

Dollar, David and Aart Kraay. 2003. Institutions, trade, and growth. *Journal of Monetary Economics*, 50, 133-162.

Edwards, Sebastian. 1993. Openness, trade liberalization, and growth in developing countries. *Journal of Economic Literature*, 31, 1358-1393.

Edwards, Sebastian. 1998. Openness, productivity, and growth: What do we really know? *Economic Journal*, 108, 383-398.

Engel, Charles and John H. Rogers. 1996. How wide is the border? *American Economic Review*, 86, 1112-25.

Fatás, Antonio and Ilian Mihov. 2001. Government size and automatic stabilizers: international and intranational evidence. *Journal of International Economics*, 55, 3-28.

Frankel, Jeffrey A. and David Romer. 1999. Does trade cause growth? *American Economic Review*, 89 (3), 379-399.

Fujii, Eiji. 2015. Reconsidering the price-income relationship across countries. *Pacific Economic Review*, 20 (5), 733-760.

Goldberg, Pinelopi K. and Frank Verboven. 2005. Market integration and convergence to the Law of One Price: evidence from the European car market. *Journal of International Economics*, 65 (1), 49–73.

Goldfajn, Ilan and Rodrigo O. Valdéz. 1999. The aftermath of appreciations. *Quarterly Journal of Economics*, 114, 229-262.

Harrigan, James. 1996. Openness to trade in manufactures in the OECD. *Journal of International Economics*, 40, 22-39.

Harrison, Ann. 1996. Openness and growth: A time-series, cross-country analysis for developing countries. *Journal of Development Economics*, 48, 419-447.

Harrison, Ann and Andrés Rodríguez-Clare. 2010. Trade, foreign investment, and industrial policy for developing countries, in Dani Rodrik and Mark R. Rosenzweig (eds), *Handbook of Development Economics Volume 5*, Amsterdam: North-Holland.

Head, Keith and Thierry Mayer. 2014. Gravity equations: Workhorse, toolkit, and cookbook, in Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff (eds), *Handbook of International Economics Volume 4*, Amsterdam: North-Holland.

Kalemli-Ozcan, Sebnem, Bent E. Sørensen and Oved Yosha. 2003. Risk sharing and

industrial specialization: Regional and international evidence. *American Economic Review*, 93, 903-918.

Kravis, Irving B. and Robert E. Lipsey. 1987. The assessment of national price levels, in *Real Financial Linkages among Open Economies*, ed. by Sven W. Arndt and J. David Richardson (Cambridge, Massachusetts, MIT Press).

Kravis, Irving B. and Robert E. Lipsey. 1988. National price levels and the prices of tradables and nontradables. *American Economic Review*, 78 (2), 474-478.

Krugman, Paul. 1991. *Geography and trade*. MIT Press, Cambridge MA.

Leamer, Edward E. 1988. Measures of openness, in R. Baldwin, ed., *Trade Policy Issues and Empirical Analysis*, National Bureau of Economic Research Conference Report Series, Chicago: University of Chicago Press, 147-200.

Levi Yeyati, Eduardo and Ugo Panizza. 2011. The elusive costs of sovereign defaults. *Journal of Development Economics*, 94, 95-105.

Levine, Ross and David Renelt. 1992. A sensitivity analysis of cross-country growth regressions. *American Economic Review*, 82, 942-963.

Parsley, David C. and Shang-Jin Wei. 2001. Explaining the border effect: the role of exchange rate variability, shipping costs, and geography. *Journal of International Economics*, 55, 87-105.

Pritchett, Lant. 1996. Measuring outward orientation in LDCs: Can it be done? *Journal of Development Economics*, 49, 307-335.

Ram, Rati. 2009. Openness, country size, and government size: Additional evidence from a large cross-country panel. *Journal of Public Economics*, 93, 213-218.

Rodriguez, Francisco and Dani Rodrik. 2000. Trade policy and economic growth: A skeptic's guide to the cross-national evidence, in Ben S. Bernanke and Kenneth Rogoff (eds.), *NBER Macroeconomics Annual 2000*, Cambridge: The MIT Press.

Rodrik, Dani. 1998. Why do more open economies have bigger governments? *Journal of Political Economy*, 106 (5), 997-1032.

Romer, David. 1993. Openness and inflation: Theory and evidence. *Quarterly Journal of Economics*, 108 (4), 869-903.

Table 1. Trade openness

	N	Mean	Standard deviation	Coefficient of variation	Minimum	Maximum
A. Intra-national						
Japanese prefectures	47	132.83	32.91	24.77	63.45 (Okinawa)	215.44 (Mie)
B. International						
All countries	171	87.90	49.67	56.50	23.71 (Brazil)	373.29 (Singapore)
OECD countries	34	83.27	46.64	56.01	24.17 (Japan)	274.43 (Luxembourg)
EU members	28	99.46	47.58	47.83	48.44 (Italy)	274.43 (Luxembourg)
Euro-zone countries	19	106.63	54.93	51.52	48.44 (Italy)	274.43 (Luxembourg)

Notes: The descriptive statistics in percentage terms are presented for the 1996-2009 average trade openness of the prefectures and the countries specified in the first column.

Table 2. Comparison of the samples

	Japan	Euro-zone	EU	OECD	World
Economic development	Developed	Developed	Developed	Developed	Developed and less developed
Common market	Yes	Yes	Yes	No	No
Common currency	Yes	Yes	No	No	No
Geographical clustering	Yes	Yes	Yes	No	No
Common fiscal system	Yes	No	No	No	No
Sample size	47	19	28	34	171
Trade openness (%)	132.83	106.63	99.46	83.27	87.90
	(32.91)	(54.93)	(47.58)	(46.64)	(49.67)
GDP (USD billions)	94.79	487.63	444.67	959.67	240.22
	(125.70)	(760.15)	(710.78)	(2087.78)	(1006.12)
Population (millions)	2.70	17.14	17.59	34.60	35.26
	(2.55)	(24.60)	(22.54)	(55.10)	(132.57)
Distance (km)	519	1562	689	3598	Not available
	(180)	(407)	(208)	(2103)	

Notes: The numerical entries in the bottom four rows are the sample means and the standard deviations in the parentheses. The inter-country distances are calculated by using the calculator at http://www.infoplease.com/atlas/calculate-distance.html.

Table 3. Correlations between trade openness and the alternative measures

	Trade openness	Remoteness	Price deviations (Clothing)	Price deviations (Furniture)	Scale economy (Population)
Remoteness	-0.671**				
	[-6.078]				
Price deviations	-0.218	0.423**			
(Clothing & footwear)	[-1.505]	[3.133]			
Price deviations	-0.125	-0.134	0.304*		
(Furniture & household utensils)	[-0.850]	[-0.908]	[2.142]		
Scale economy	0.043	-0.199	0.247†	0.145	
(Population)	[0.289]	[-1.362]	[1.715]	[0.985]	
Specialization	0.732**	-0.361*	-0.134	-0.182	-0.141
	[7.138]	[-2.571]	[-0.902]	[-1.232]	[-0.950]

Notes: The entries indicate correlation coefficients based on averages of 1997, 2002, and 2007 data. The entries in the brackets are t-statistics for the null hypothesis of no correlations. Due to the data constraints, the sectoral specialization index is not calculated for Okinawa prefecture. Consequently, the rank correlations between the specialization index and others are based on 46 prefectures. For all others, the correlations are based on all of the 47 prefectures. **, *, and † indicate the statistical significance at the 1, 5, and 10 % levels.

Table 4. Rank correlations between trade openness and the alternative measures

	Trade openness	Remoteness	Price deviations (Clothing)	Price deviations (Furniture)	Scale economy (Population)
Remoteness	-0.654**				
	[-5.803]				
Price deviations	-0.076	-0.012			
(Clothing & footwear)	[-0.515]	[-0.085]			
Price deviations	-0.087	-0.079	0.131		
(Furniture & household utensils)	[-0.587]	[-0.537]	[0.891]		
Scale economy	0.129	-0.341*	0.227	-0.203	
(Population)	[0.874]	[-2.440]	[1.567]	[-1.396]	
Specialization	0.739**	-0.317*	-0.195	-0.142	-0.187
	[7.358]	[-2.249]	[-1.337]	[-0.967]	[-1.277]

Notes: The entries indicate Spearman rank correlation coefficients based on averages of 1997, 2002, and 2007 data. The entries in the brackets are t-statistics for the null hypothesis of no association between the rank pairs. Due to the data constraints, the sectoral specialization index is not calculated for Okinawa prefecture. Consequently, the rank correlations between the specialization index and others are based on 46 prefectures. For all others, the rank correlations are based on all of the 47 prefectures. ** and * indicate the statistical significance at the 1 and 5% levels, respectively.

Table 5. Regression estimates

	1	2	3	4	5	6	7	8	9
Remoteness		-.296**				-.220**	-.221**	-.238**	-.238**
		(.036)				(.023)	(.023)	(.029)	(.029)
Price deviations			-.005				-.001		.0001
			(.009)				(.005)		(.005)
Specialization				.793**		.651**	.649**	.623**	.623**
				(.078)		(.063)	(.064)	(.070)	(.070)
Population					.002			-.028	-.028
					(.026)			(.022)	(.022)
Year dummy	Included	Included	Included	Included	Included	Included	Included	Included	Included
Adjusted R^2	.021	.396	.016	.496	.014	.690	.687	.693	.690
F-statistics	2.499†	31.022**	1.780	45.999**	1.657	77.233**	61.370**	62.922**	52.038**
N	138	138	138	138	138	138	138	138	138

Notes: The entries summarize the OLS estimates of (10) in the main text using the 1997, 2002, and 2007 pooled sample. Due to the data constraints on the sectoral output, Okinawa prefecture is excluded from the sample. The year specific intercepts are included in all specifications. Price deviations are those for clothes and foot wears. **, *, and † indicate the statistical significance at the 1, 5, and 10 % levels.

Table 6. Variance decomposition

	(i) Var(ln GDP)	(ii) Var(ln TRADE)	(iii) Covariance	(iv) (ii) / (i)	(v) (iii) / (i)
A. Intra-national					
Japanese prefectures	922.34	1090.12	956.23	1.18	1.03
B. International					
All countries	2066.90	1958.83	1962.86	0.94	0.94
OECD countries	1044.81	750.58	847.70	0.71	0.81
EU countries	1680.93	1332.58	1456.75	0.79	0.86
Euro-zone countries	1616.45	1246.54	1381.49	0.77	0.85
C. Within country group					
OECD countries	774.61	570.84	622.72	0.73	0.80
EU countries	1324.17	1076.01	1150.09	0.81	0.86
Euro-zone countries	1443.01	1205.59	1275.80	0.83	0.88

Notes: The entries in columns (i), (ii), and (iii) denote the contributions in percentage terms of the variance of logged GDP, variance of logged trade, and their covariance, respectively, to the variance of logged trade openness based on the 1997, 2002, and 2007 data. The entries in column (iv) and (v) are the ratios of those in columns (ii) to (i) and those in (iii) to (i), respectively. In panel B, the trade openness is calculated by the sum of export and import vis-à-vis the rest of the world, whereas in panel C the trade vis-à-vis other member countries within the denoted group is counted.